ASSESSING THE DIVERSITY OF INVASIVE AND NATIVE PLANT SPECIES AND THEIR IMPACT ON SOIL CARBON IN HARYANA'S VILLAGE FOREST ECOSYSTEMS.

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"Assessing the diversity of Invasive and Native plant species and their impact on soil carbon in Haryana's Village Forest Ecosystems"

Introduction

Biodiversity refers to the variety of life or diversity in the living world, and it is an essential compoonent of Earth's ecosystems. Biodiversity fosters a close bond between humans and their surroundings by supplying food, housing, wood, medicine, and other essential ecosystem services. India has around 8% of total biodiversity of the world. Of this a treasure trove of biodiversity resides in the forests, hosting approximately 47,000 plant species and 89,000 animal species, including many that are endemic and endangered (MoEFCC, 2020). These ecosystems are vital to the survival of many endangered and locally endemic species (Karanth et al., 2010).

However, these rich ecosystems face significant threats from deforestation, poaching, and climate change, which have led to a loss of habitat and decline in wildlife populations (WWF, 2020). Land use change is one of the most serious threats to the biological diversity all around the world (Sala et al., 2000). As the human population grows, significant environmental changes occur as a result of activities like deforestation, industrialisation, urbanisation, and the exploitation of all natural resources, resulting in biodiversity loss. Every year, around 100 plants globally become extinct (Kumar and Verma, 2014).

Biodiversity declines as a result of rising agricultural demand, which puts pressure on forests and leads to land clearing for agriculture. As a result, vegetation disperses and native species begin to disappear in that area. Apart from agriculture, there are several other anthropogenic demands on forest resources in India's various regions, as more than 200 million people rely on forests for their survival (Gupta and Kumar, 2014). The rising demand for plant-based pharmaceuticals is putting a strain on wild populations (Vidyarthi et al., 2013) resulting in their extinction as a result of over-exploitation. Therefore, concerns are raised worldwide over the rapid loss of biodiversity in all its forms and at all levels.

Haryana is primarily an agrarian state in North India. Out of a total of 22 districts in Haryana, 21 districts have less than 20% forest and tree cover. The state is witnessing a rapid decline in tree cover too, as reported by the Forest Survey of India, with a 140 sq km reduction in the tree cover (excluding forest area) from 2019 to 2020.

As per Forest Survey of India, 2021, Haryana has a forest cover of about 1,588 square kilometers only, which constitutes approximately 3.6% of the state's geographical area. Village forests, specifically, play a critical role within this limited forest cover. These community-managed forests contribute significantly to local biodiversity and rural livelihoods.

According to the Forest Survey of India (2021), the recorded forest area under community ownership, which includes village forests, is approximately 56 square kilometers in Haryana. These village forests are crucial for local communities, providing resources such as fuelwood, fodder, and non-timber forest products. Moreover, they serve as vital green spaces that enhance the environmental quality and sustainability of rural areas in the state.

But these Village forests in Haryana are increasingly experiencing environmental stress due to factors such as deforestation, over-exploitation, and climate change. Agricultural expansion and urbanization have led to significant deforestation, reducing forest cover and fragmenting habitats (Forest Survey of India, 2021). Over-harvesting of fuelwood and non-timber forest products, coupled with overgrazing by livestock, further degrades these forests, leading to soil erosion and loss of biodiversity (MoEFCC, 2020). Additionally, climate change poses a serious threat through altered rainfall patterns and increased frequency of extreme weather events, which impact forest health and regeneration (Centre for Science and Environment, 2021).

Invasive species are considered as the second major threat to the loss of species diversity worldwide (Vitousek et al., 1996). Invasive plant species (IAS) have been introduced (intentionally/unintentionally) to the areas where they were not present before, but after establishment may perform better than resident native plants and may decrease in their abundance and dominance in the invaded habitats (Mack et al., 2000; D'Antonio & Meyerson, 2002). They have the potential to generate fertile progeny (despite human interference), typically in enormous numbers or quantities, at great distances from their parent plants, and hence have the ability to spread over a broad area (Richardson et al., 2000).

Because IAS are now seen as a substantial component of global change (Simberloff, 1996; Sakai et al., 2001), they have gained special significance. Foresters, ecologists, and taxonomists are well aware of issues posed by biotic invasions in natural environments. Hence, in recent years, extensive research has been performed on biological invasion, reflecting that the problem of alien species is increasing globally.

Therefore, the present study focuses on the understanding the plant invasion along with native phytodiversity of these village forests in Haryana. This will be helpful in making effective conservation strategies and sustainable management practices are essential to mitigate environmental stress and ensure the ecological and socio-economic sustainability of these ecosystems.

Review of literature

The study of plant community structure and species diversity is critical for forest ecology, comprising the determination of the contribution of numerous species to the structure as well as the function of that particular forest ecosystem. The periodic observations of forests provide data on the recruitment, replacement, aggregation, and abundance of species as a result of change in their habitat (Pimm et al., 1995). Additionally, vegetation analysis aids in the understanding of the patterns and processes underlying tropical forest diversity (Valencia et al., 1994).

The amount of C in soil is around three times more than vegetation and twofold as much as present in the atmosphere, thus is highly significant (Batjes and Sombroek, 1997). The movement of C between the above ground environment & soil is bidirectional and storage of C in soils shows the balance between the processes opposing its accumulation & loss consequently. Soil C is not an inert reservoir and is associated with the organic matter that is imperative for upholding soil fertility, thus plays significant role in nutrient cycling & gaseous exchange. All this makes soil carbon an important parameter during ecological studies.

A large number of studies have been carried out in the direction of plant invasion in India (Love et al., 2009; Naithani et al., 2017; Singh et al., 2017; Sakachep and Rai, 2021; Gupta and Malhotra, 2022; Sahoo and Nayak, 2022; Sharma et al., 2023; Hansda et al., 2024) and a few have been conducted in the forest ecosystems of Haryana (Kohli et al., 2009; Saharan et al., 2021; Dhiman et al., 2021; Jakhar et al., 2024). But there is a notable lack of literature on such studies in the village forests of Haryana state.

The native flora in Haryana's village forests contributes significantly to biodiversity and ecosystem services, including soil carbon sequestration (Singh et al., 2019). Conversely, invasive species, have been found to disrupt native plant communities and alter soil properties, often reducing soil carbon levels (Rao et al., 2018). Research highlights the importance of maintaining native vegetation to enhance soil health and carbon storage (Sharma et al., 2020). Additionally, comparative studies on soil carbon under different vegetative covers emphasize the role of plant diversity in promoting soil organic matter (Kumar & Jhariya, 2017). Understanding these dynamics is crucial for developing effective management practices to preserve biodiversity and optimize soil carbon sequestration in Haryana's village forests.

Objectives

The following objectives are made for the present study:

1. To investigate the composition and analytical characterstics of the native and invasive flora of selected village forest ecosystems of Haryana.
2. To study the diversity indices of native and invasive flora in the village forest ecosystems.
3. To investigate the soil carbon assessment in the selected village forest ecosystems.
4. To identify the types and intensity of human intervention in the village forests chosen during the present study.

Materials and Methodology:

Study site:

The study will be conducted in the Village forest ecosystems of Haryana in the districts -Hisar, Jind, and Bhiwani. These districts are affected by the local steppe climate and are situated in an arid area of Haryana. A small amount of rain falls throughout the year. The Bhiwani has an average annual temperature of 25.2C and 465 mm of precipitation. Hisar's average temperature is 25.1 C. Every year, about 459 mm of precipitation falls. On the other hand, Jind experiences an average yearly temperature of 29.62 C and 515 mm of rainfall.

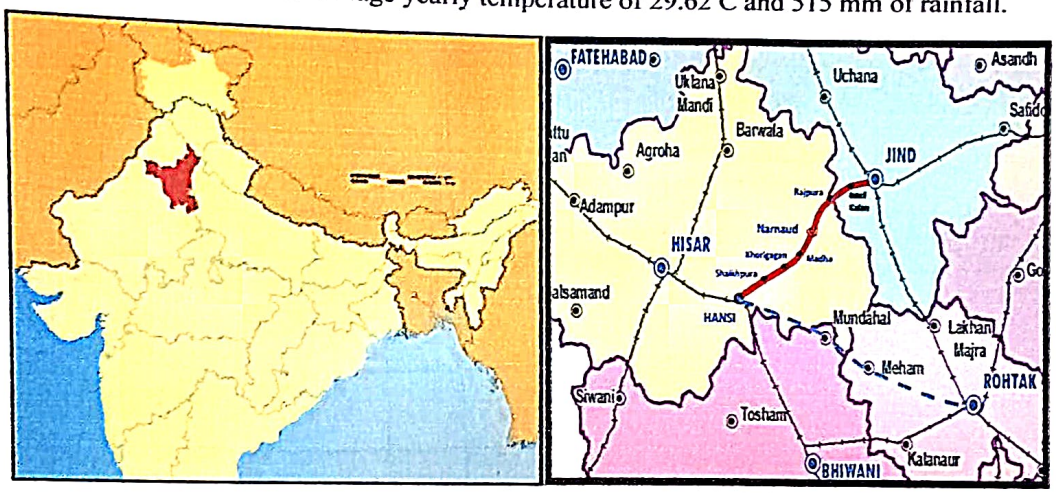

Fig. 1: Location of Haryana with respect to India (Left) and the selected districts under study (Right).

Methodology

For objective 1:

The size of the quadrat suitable for the study will be determined by the species-area curve method. Quadrats of calculated dimension will be laid randomly to enumerate the mature trees covering a minimum of 8% of the total area. Plant species within the quadrats will be identified, and the number of trees of each species will be counted. The circumference at breast height (CBH) of each plant species will also be measured within the quadrat with the help of measuring tape or Vernier Caliper.

In accordance with Phillips (1959) and Mishra (1968), the frequency, density, abundance, basal area, and important value index of the trees, shrubs, and herbs will be examined. In accordance with Curtis and McIntosh (1951), the importance value index (IVI) for trees and shrubs will be computed as follows: relative density (%) + relative frequency (%) + relative basal area (%)

For objective 2:

For this, following diversity indices will be calculated using the given methodology-

i. Shannon and Wiener equation (1963).
ii. Concentration of dominance (C) will be measured by Simpson's index (1949).
iii. Equitability (e) will be calculated following Pielou (1966).
iv. Margalef's index of Species richness (d) will be calculated following Margalef (1958).

For objective 3:

For soil carbon analysis, soil sample is to be collected from each quadrate at three depths (0-15cm, 15-30cm and 30-45cm). This sample will be taken to laboratory and its organic and inorganic soil carbon content will be calculated by soil depth, bulk density, and organic & inorganic C concentration (%) in soil for the corresponding depth.

Soil organic carbon will be analyzed by using the dichromate oxidation method (Kalembasa and Jenkinson, 1973) and inorganic carbon will be estimated by Rapid titration method (Walkley and Black, 1934).

For objective 4

To identify the types and intensity of human intervention in the village forests, various ecosystem disturbances like habitat fragmentation, tree cutting, overharvesting, overgrazing of animals, etc. will be noted during the field visits. The degree/intensity of disturbance will be deliberated considering these parameters, and the sites will be classified according to the varying scores of the perceived disturbance i.e., 1=low, 2=medium, 3=high. Site with a score of <10 is classified as a low disturbance site while the site having a score of 10-20 as a medium disturbance site and with a score of >20 as a high disturbance site (Ramírez-Bravo and HernándezSantin, 2016).

Significance

Conducting a study on the diversity of native and invasive flora in the village forests of Haryana and their impact on soil carbon assessment is vital for several reasons. Ecologically, understanding the variety of native plant species and their roles in ecosystem functions is crucial for biodiversity conservation and ecosystem resilience. Identifying and managing invasive species, which disrupt native plant communities and soil properties, is essential for preserving biodiversity and preventing ecosystem degradation. From an environmental perspective, assessing the influence of different plant species on soil carbon levels provides valuable insights into soil health and carbon sequestration, critical for climate change mitigation. Economically and socially, village forests are integral to rural livelihoods, providing resources such as fuelwood, fodder, and non-timber forest products. Understanding how flora diversity affects these resources can help sustain and improve rural economies. Moreover, findings from this study can guide policymakers and forest managers in developing effective conservation and land management strategies, balancing ecological health with socio-economic needs, and enhancing soil health to support atmospheric carbon sequestration and sustainable forestry.

References:

1. Buringh, P., & Buringh, P. (1979). Introduction To The Study Of Soils In Tropical And Subtropical Regions (No. 631.4913 B8 1979.). Wageningen: Pudoc
2. Curtis, J. T. & Mc- Intosh, R. P. (1951). An upland forest continuum in the prairie forest region of Wisconsin. Ecology, 32 : 476-496.
3. Curtis, J. T. (1959). The vegetation of Wisconsin: an ordination of plant communities. The University of Wisconsin Press.
4. Dudal, R. (1980). Soil-Related Constraints To Agricultural Development In The Tropics. Soil-Related Constraints To Food Production In The Tropics, 23-37.
5. Gentry, A. H. (1988). Changes In Plant Community Diversity And Floristic Composition On Environmental And Geographical Gradients. Annals Of The Missouri Botanical Garden, 1- 34.
6. Harikesh, H., & Jakhar, S. Floristic diversity and vegetation analysis of the community forests of South-West Haryana, India.
7. Pimm, S. L., Russell, G. J., Gittleman, J. L., & Brooks, T. M. (1995). The Future Of Biodiversity. Science, 269(5222), 347-350.
8. Guha, R. (1983). Forestry In British And Post-British India: A Historical Analysis. Economic And Political Weekly, 18(45–46)
9. Kumar, A., & Verma, B. (2014). biodiversity is important for ecological Balance and Human survival, 4(1): 22-32i.
10. Pouchepadass, J. (1995). Colonialism And Environment In India: Comparative Perspective. Economic And Political Weekly, 2059–2067.
11. Punia, H., Dhiman, H., Saharan, H., & Jakhar, S. Floristic Composition and Diversity in Response to Varying Degrees of Disturbance in Tropical Dry Deciduous Forests of Southern Haryana, India.
12. Rawat, M., Arunachalam, K., Arunachalam, A., Alatalo, J., & Pandey, R. (2019). Associations Of Plant Functional Diversity With Carbon Accumulation In A Temperate Forest Ecosystem In The Indian Himalayas. Ecological Indicators, 98, 861-868
13. Raychaudhuri, S. P., & Mathur, L. M. (1954). A Basic Land Resource Map Of India. Reprint From The Bull. Nat. Inst. Sci". India, (3).
14. Rodgers, W.A., & Panwar H.S. (1988). Planning a wildlife protected area network in India. Food and Agriculture Organization of the United Nations, Dehra Dun, India.
15. Raunkiaer, C. (1934). The life forms of plants and statistical plant geography, Clarendon press, Oxford, pp. 632.

16. Richardson, D. M., Pyšek, P., Rejmánek, M., Barbour, M. G., Panetta, F. D., & West, C. J. (2000). Naturalization and invasion of alien plants: concepts and definitions. Diversity and distributions, 6(2), 93-107.

17. Sanchez, P.A. (1976). Soil Management In Rice Cultivation Systems. In: Properties And Management Of Soils In Tropics. John Wiley And Sons, New York, Pp. 413–477.

18. Sala, O. E., Stuart Chapin, F. I. I. I., Armesto, J. J., Berlow, E., Bloomfield, J., Dirzo, R., ... & Wall, D. H. (2000). Global biodiversity scenarios for the year 2100. science, 287(5459), 1770-1774.

19. Upadhyaya, S. D. (1955). Soil Formation In Relation To Plant Cover. Ph.D. Thesis, Univ. Saugar.

20. Valencia, R., Balslev, H., & Paz Y Miño, G. (1994). High Tree Alpha-Diversity In Amazonian Ecuador. Biodiversity And Conservation 3: 21-28.

21. Vidyarthi, S., Samant, S. S., & Sharma, P. (2013). Traditional and indigenous uses of medicinal plants by local residents in Himachal Pradesh, North-Western Himalaya, 169 India. International Journal of Biodiversity Science, Ecosystem Services & Management, 9(3), 185- 200.

22. Wang, Y., Li, Y., Ye, X., Chu, Y., & Wang, X. (2010). Profile Storage Of Organic/Inorganic Carbon In Soil: From Forest To Desert. Science Of The Total Environment, 408(8), 1925- 1931.

23. Wang, S., Zhuang, Q., Jia, S., Jin, X., & Wang, Q. (2018). Spatial variations of soil organic carbon stocks in a coastal hilly area of China. Geoderma, 314, 8–19.